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ATTRACTIVENESS OF CARBON DISULFIDE TO WILD NORWAY RATS

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ABSTRACT: In laboratory experiments, carbon disulfide (CS_2) increases the attractiveness of feeding stations to rats and mice. Bait consumption is also increased, and the effects are more pronounced for females than for males. The present study was designed to assess whether CS_2 would enhance consumption of a standard bait formulation by wild Norway rats (Rattus norvegicus). The results showed that consumption was tripled when bait was paired with CS_2. We speculate that CS_2 could similarly enhance the effectiveness of rodenticide bait formulations to which it is applied. Extensive field tests of CS_2 as a rodent attractant appear warranted.

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When faced with a choice among feeding sites, Norway rats prefer locations that conspecifics are exploiting (Galef and Clark 1971, Galef and Heiber 1976). When faced with a choice among several novel foods, naive (observer) rats choose novel foods eaten by conspecifics (demonstrators) with whom they have previously interacted (Galef and Wigmore 1983, Posadas-Andrews and Roper 1983, Strupp and Levitsky 1984). Laboratory experiments have shown that these effects are mediated by volatile cues present in the breath of demonstrators (Galef and Stein 1985). Such cues could be the smell of food that a demonstrator has ingested before interacting with an observer. Alternatively, the social transmission of diet preferences might require a combination of the smell of ingested diet and some endogenous (demonstrator-derived) odor. In a series of experiments designed to test between these two possibilities, Galef and Stein (1985) and Galef etal. (1985) showed that both the smell of ingested diet and demonstrator-produced odors (i.e., semiochemicals) were important.

In gas chromatography/mass spectroscopic experiments that were designed to identify candidate semiochemicals (Galef et al. 1988), we found that carbon disulfide (CS_2) and carbonyl sulfide were present on the breath of rats in relatively high concentrations (1-2 ppm). When 1-ppm CS_2 was associated with diet on a surrogate rat (cotton batting), it elicited transfer of diet preference similar to that produced by exposure to a live demonstrator (Galef et al. 1988). In addition, when 0.1-10.0-ppm CS_2 was applied to food and presented to house mice (Mus musculus): (a) consumption increased significantly; and (b) bait stations containing scented food were entered more frequently and for longer periods that bait stations containing unscented food (Bean et al. 1988).

The present study was designed to probe the attractiveness of CS_2 to wild Norway rats, and to determine whether it would significantly enhance their consumption of novel food.

METHODS

Study sites

Three locations were selected in the vicinity of Poughkeepsie, N.Y. All locations had large populations of Norway rats (Rattus norvegicus), as indicated by multiple burrow openings, tracks, and feces, and as confirmed by visual observations. The first site was a horse barn (30 x 15 x 10 m) located 8 km northeast of the city limit. The second site was a livestock feeding pen. This location was 3 km east of the city limit. The final location was the pheasant holding pens of a large private gun club located 25 km east of Poughkeepsie.

Apparatus

Bait stations were pairs of 50-cm long x 10-cm diameter sections of PVC pipe. The pipes were attached side-by-side with wire (Fig. 1). One end of each pipe was open, while the other was closed with a removable PVC cap. Inside each cap, for each session described below, 3 ICI Americas Rodent Indicator Bait Blocks (Bait Blocks) were attached with wire (to prevent removal of whole blocks by rats). The only difference between the pipes in each pair was that one pipe also contained a vial filled with 10 ml of 10-ppm CS_2. Vials were attached to the PVC cap immediately above the Bait Blocks, and were fitted with 6-cm long x 2-cm wide cloth wicks that protruded 2 cm from the cap of the vial. The 10-ppm CS_2 concentration was chosen for testing on the basis of laboratory evidence (Bean et al. 1988). A fine suspension was prepared by diluting reagent grade CS_2 (Sigma) in distilled water, and agitating for approximately 30 min.

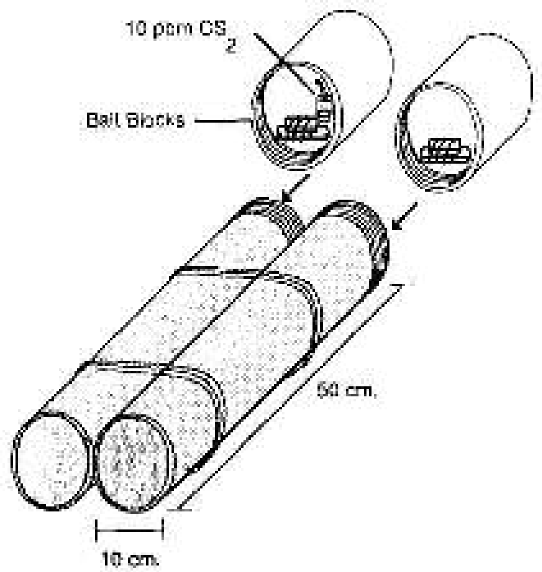

Fig. 1. Diagram of a bait station. ICI Americas Indicator Bait Blocks were wired into the caps on each PVC pipe. CS_2 was associated with the Bait Blocks in one tube.

Procedure

Three locations were randomly selected at each of the 3 test sites, with the qualification that the locations were at least 15 m apart. Over 6 days, a bait station was placed at each location at each site twice, in sequential order. For all 6 tests at each site, bait stations were set out at approximately 1700 hrs, and retrieved at 0900 hrs of the following day. The pipe in each pair that contained CS_2 was counterbalanced across tests, and total consumption (g) of Bait Blocks on each test night was assessed.

Consumption of CS_2 Bait Blocks and plain Bait Blocks at each test site was assessed in 3 2-tailed paired t-tests. In addition, differences in consumption between plain and scented Bait Blocks were computed, and these difference scores were examined in a 1-way analysis of variance to determine whether patterns of consumption varied among test sites.

RESULTS AND DISCUSSION

Consumption of CS_2 Bait Blocks was significantly higher than consumption of plain Bait Blocks at all 3 sites (t=2.83, 2.30, 2.56, respectively; df=5, $P<0.03$; Fig. 2). Moreover, the analysis of variance showed that there were no differences in patterns of consumption among sites (F=0.79; 2, 15 df; $P>0.25$). When overall means were computed, consumption of CS_2 Bait Blocks was three times higher (mean + s.e.m. = 10.7 $\pm$ 2.7 g) than consumption of plain Bait Blocks (mean + s.e.m. = 3.2 $\pm$ 1.1 g). These findings are consistent with laboratory evidence that CS_2 is attractive to rodents and that it substantially increases their consumption of novel foods.

Inspection of nightly test results (Fig. 2) suggests that overall consumption increased during the course of the assessment. This increase could reflect diminishing neophobia to the bait station s and/or baits. Interestingly, even on the first test, CS_2 enhanced consumption. This enhanced consumption even during initial exposure of bait is consistent with laboratory results demonstrating CS_2 decreases neophobia exhibited by rats towards novel foods (Galef unpubl. obs.).

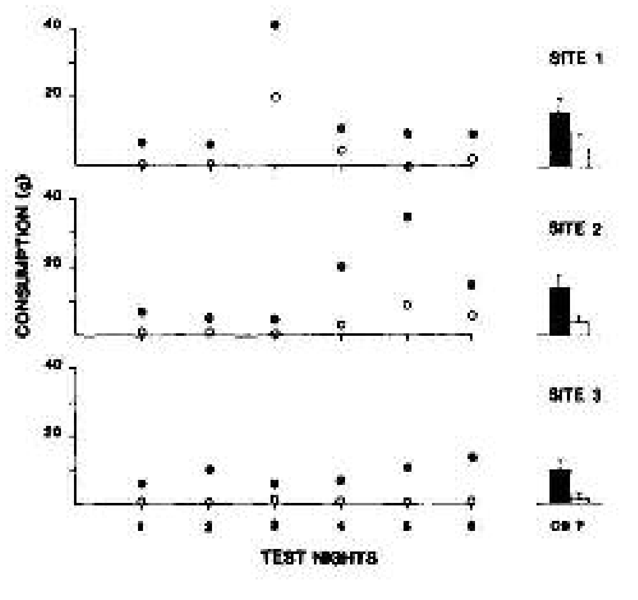

Fig. 2. (Left panel) Consumption at each site during the 6 tests. Open dots represent nightly consumption (g) of unscented Bait Blocks. Shaded dots represent nightly consumption of scented (CS_2) Bait Blocks. (Right panel) Mean consumption at each site, collapsed across tests. Open and stippled bars represent overall consumption (g) of unscented and scented Bait Blocks, respectively. Capped vertical bars represent standard errors of the means (SEM).

Conceivably, the attractiveness of CS_2 in the present study reflects neophilia, or curiosity, for a novel odor. This explanation does not seem likely, given that a large body of evidence suggests that rats avoid, rather than approach, novel items in their environments, at least when food and water supplies are abundant. Also, in previous assessments, we compared the attractiveness of baits scented with CS_2 versus baits scented with another odorant (n-butanol). Whereas butanol was no more attractive than distilled water, CS_2 increased (a) entries into bait enclosures, (b) the amount of time spent in bait enclosures, and (c) the amount of bait consumed. While it is possible that other odorants are as attractive to rodents as CS_2, the present data and laboratory evidence (Bean et al. 1988, Galef et al. 1988) are consistent with the notion that CS_2 is an endogenous, biologically meaningful odor for rats and mice. By signalling "safety," CS_2 increases the attractiveness of materials to which it is applied.

MANAGEMENT IMPLICATIONS

Carbon disulfide attracts both rats (Galef et al. 1988, present study) and mice (Bean et al. 1988) to bait stations. In addition, CS_2enhances consumption of novel diets both in the laboratory and in the field. We speculate that CS_2 could similarly enhance the consumption of rodenticide bait formulations to which it is applied. Further, laboratory experiments (Bean et al. 1988, Galef et al. 1988) have shown that CS_2 increases entries and time spent in areas where it is present. Application of CS_2 may, therefore, increase the effectiveness of traps and tracking powders by increasing the investigation of these devices and materials by rodents.

Carbon disulfide may increase the effectiveness of poison baits in ways that extend beyond simple enhancement of initial intake. Results of 4 recent sets of experiments (Galef 1986a, 1986b, 1987; Galef et al. 1988) indicate that experience with the smell of a diet, either on the breath of a conspecific, or in association with CS_2, interferes with rats' ability to acquire a subsequent aversion (bait-shyness) towards that diet. Thus, it is possible that presence of CS_2 in a bait may not only increase initial consumption of that bait, but also may increase the probability that an individual consuming a sublethal dose of a bait on a first visit to a bait station will return for a second visit.

ACKNOWLEDGMENTS

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